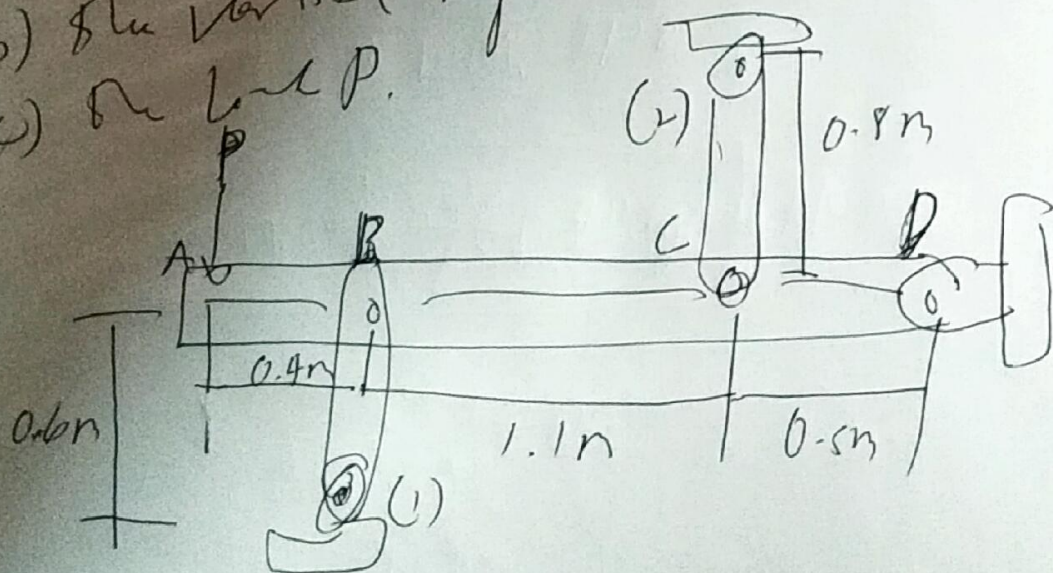


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Rigid bar ABCD is loaded and supported as shown in the figure. Bars (1) and (2) are unstressed before the load P is applied. Bar (1) is made of bronze [$E = 100 \text{ GPa}$] and has a cross-sectional area of 520 mm^2 . Bar (2) is made of aluminum [$E = 70 \text{ GPa}$] and has a cross-sectional area of 960 mm^2 . A P force is applied, the force in bar (2) is found to be 25 kN (in tension).

Do the following:

- The stresses in bars (1) and (2)
- The vertical deflection of point A.
- The load P .



Soln:

$$E_1 = E_{\text{bronze}} = 100 \text{ GPa} = 100 \times 10^9 \text{ MPa}$$

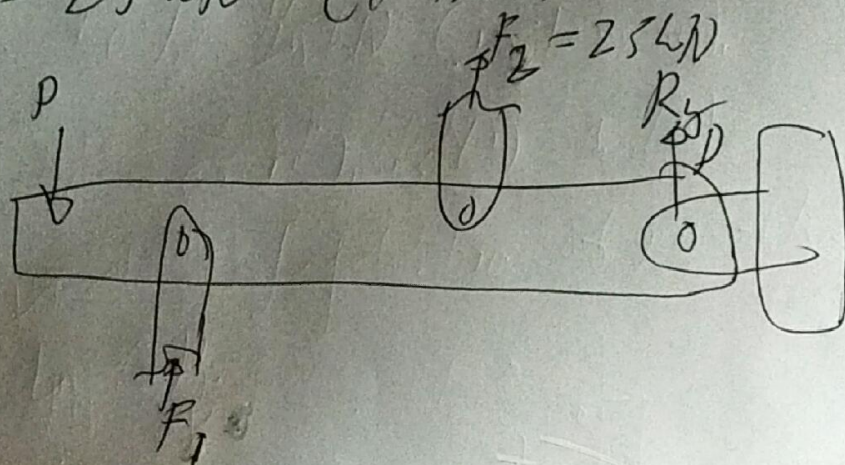
$$A_1 = 520 \text{ mm}^2$$

$$E_2 = E_{\text{aluminum}} = 70 \text{ GPa} = 70 \times 10^9 \text{ MPa}$$

$$A_2 = 960 \text{ mm}^2$$

after load P is applied:

$$F_2 = 25 \text{ kN (tension)}$$



$$\sigma_2 = \frac{25 \text{ kN}}{960 \text{ mm}^2} = 26.0417 \text{ MPa}$$

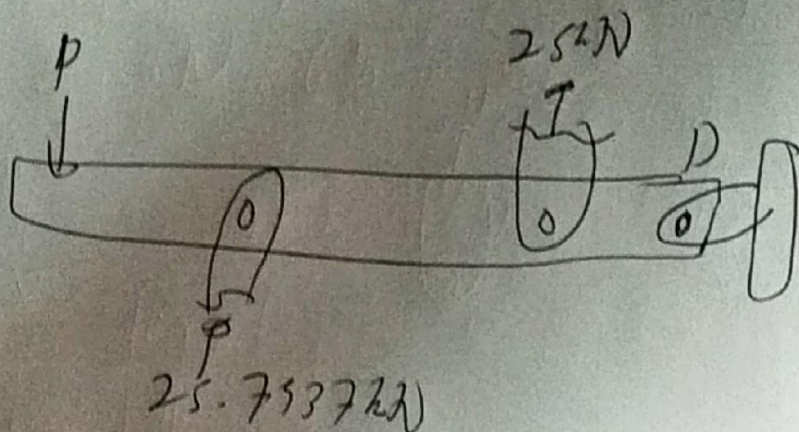
$$\delta_1 - \delta_2 = 0$$

$$\delta = \frac{\overset{\text{force}}{PL}}{AE}$$

$$\frac{F_1(0.6)}{(520)(100)} - \frac{(25)(0.8)}{(560)(70)} = 0$$

$$\therefore F_1 = 25.7937 \text{ kN}$$

$$\sigma_1 = \frac{25.7937 \text{ kN}}{520 \text{ mm}^2} = 49.6033 \text{ MPa}$$



$$M_D = 0: P(2) - 25.7937(1.6) - 25(0.5) = 0$$

$$P = 26.8850 \text{ kN}$$

By taking sum of moments: (+ = +ve sign)

$$\sum A(2) - \sum_1(1.6) + \sum_2(0.5) = 0$$

$$\sum A = \left(\sum_1 = \frac{P}{AE} \right)$$

$$\delta_1 = \frac{F_1 (0.6)}{520 (100)} = 297.6156 \times 10^{-6} \text{ mm}$$

$$\delta_2 = \frac{25 (6.8)}{(560)(70)} = 257.6190 \times 10^{-6} \text{ mm}$$

$$\delta_A = \frac{-\delta_2 (0.5) + \delta_1 (1.6)}{2}$$

$$\delta_A = -505.9518 \times 10^{-6} \text{ mm}$$

Plot again?

$$(a) \sigma_1 = 45.60 \text{ MPa}$$

$$\sigma_2 = 26.04 \text{ MPa}$$

$$(b) \delta_A = -257.6198 \times 10^{-6} \text{ mm}$$

$$(c) P = 26.89 \text{ kN}$$

deflection & elongation?

$$\frac{\delta_A - \delta_1}{2 - 1.6} = \frac{\delta_2 - \delta_1}{6.5 - 1.6} \Rightarrow \delta_A = 297.6198 \times 10^{-6} \text{ mm}$$